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APPLIED CONTROL LABORATORY

STUDENT PACK

Introduction to PLC and Design (Electro-Pneumatics System) Using Omron SYSMAC CPM2A PLC

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1.	**Problem/Project Guide:**

A PLC is an industrial microprocessor-based control system that continuously monitors the state of input devices, makes decisions using a custom program, and controls the state of devices connected as outputs. Although PLC's are relatively bulky compared to a microcontroller, they remain the most commonly-used industrial data acquisition and control devices in manufacturing and electromechanical automation. Industries such as packaging, pharmaceuticals, refineries, mines, machine shops, power plants and food all automate their systems/machinery to produce more outputs with consistently, quickly and efficiently through the use of PLCs.

As it is easily programmable to accomplish a variety of control operations, it quickly gains wider applications in industry by replacing its predecessor, the electromechanical relays. The relays are now commonly used as switches and no longer as logical controllers.

Logical systems are normally represented graphically by using state diagrams or other similar methodologies. The representation is then transformed to ladder logic diagrams and implemented in PLC by using its programming language which resembles the ladder logic diagram. The purpose of this study is to control an electro-pneumatics system by using a PLC approach.

a) Problem objectives:

- To design an electro-pneumatics sequential control system using Omron PLC
- To incorporate a faulty system with the proposed design
- To analyse the efficiency of the proposed system

b) Problem Design:

The sequential system should be designed with the following specifications:

- The sequential process is done using two double acting pneumatic cylinders and one electric conveyor.
- All sequences and timing specifications as appeared in Task 2 should be used.

Students are required to design an electro-pneumatics sequential control system using Omron PLC with its programming language. The designed pneumatics-conveyor system can be used as part of a "transportation system" that allow materials to be pushed to the conveyor using pneumatic cylinder and conveyed somewhere else as part of a manufacturing system.

To achieve the problem design students are required to perform the following tasks.

c) Tasks:

Task 1

Controller design using PLC and pneumatic circuit in order to control the movement of cylinder by the following sequences

1) Press the green button once (for non-Locking type switch) to fully extend the piston out.
2) Step 1 is performed to test the quality of the mechanical switches. In this step, the piston will hit the mechanical switch and retract. The test result should be recorded and stored in a location memory. The mechanical switch functions well or PASS if it performs successfully for 10 times (ensure that the green button is ON during operation). If there is faulty in the design, the red light is turned on and the buzzer is triggered and RESET (used a RED button) to reset the condition. Each time buzzer is triggered, it will turn on for ten seconds then stop for ten seconds and repeat continuously.

Task 2

1) Design a system in which the green button (momentary type switch) is used to turn on the system and red button (momentary type switch) to turn off the system.
2) When the system is turned on, the shaft of double acting cylinder 1 (CL1) will extend until it triggers a sensor. Then it will turn on the double acting cylinder (CL2). The CL1 shaft will retract once the cylinder CL2 is turned on. The CL2 shaft is fully extended and simultaneously turns on the conveyor belt. The CL2 shaft is

held at the extended position for fifteen seconds.

3) Once the fifteen seconds time is completed, the conveyor belt will stop running and the CL2 shaft is retracted back to the initial position and stay for five seconds. Then, step two will repeat continuously.
4) Every time the shaft of CL2 is fully extended, it will reverse the direction of conveyor belt.
5) Red Button will stop the system at any condition.

A report supported with the experiment result is expected to be produced at the end of the task. The collected data and analysis should be well presented and discussed in detail in the report.

c) Problem-solving Time-line

Activities	Week 1	Week 2	Week 3
1. Briefing, PLC exercises, brainstorming, oral interview, submission of proposal			
2. Design/programming/experiments, oral interview, individual report			
3. Analysis, oral interview, demonstration of final designed			

d) Proposal write-up

You are expected to submit a handwritten project proposal on one page of paper + attachments (e.g. a flowchart for software based project). Each write-up is to be submitted as teamwork on the **first week** of the laboratory. Please ensure that each team member is responsible enough to contribute in completing the work. Your proposal may include the following information:

- title
- objective
- problem statement
- methodology (flow chart/block diagram/list of equipment, materials)
- expected outcome

e) Report writing

A group report needs to be submitted in the **post week** after the third week of laboratory session. Your report should follow the general guide by the Laboratory Coordinator such as abstract, introduction, methodologies etc.

Other than the general guide, your report for this laboratory may also include:

- Review and circuit diagrams
- Data and graph as a results
- Photographs of the actual circuit construction
- Photographs of your group members

f) Questions That Can Help You Tackle The Problem

1) How does pneumatic cylinder work?
2) How does the valve operated?
3) What is:
    a. Timer
    b. Counter
    c. Pneumatic gripper
    d. hold circuit
    e. interlocking
    f. limit switch
4) How do you define the accuracy of the design?

2. Equipment list:

(a) SMC Pneumatic Training kit (SMC panel and modules)
(b) Omron SYSMAC CPM2A PLC

3.	**Components list:**
	(a) Connector (b) Jumper wire, wire (c) Pneumatic air tubes
4.	**Software:**
	(a) PLC programming software: CX-ONE Programmer (b) Microsoft Excel
5	**Additional resources:**
	Materials related to the problem/project. Can be technical papers, short manual on how to use CX-ONE programmer software or other software for a particular problem/project, links to websites etc. Examples as follows: (a) Omron, 2001, "A Beginner's Guide to PLC", Omron Singapore. (b) Omron, 2001, "CX-programmer User Manual version 2.1. (c) SMC Trainer – User manual (d) Exercises of SMC pneumatic (e) Please refer to page 2-24 (A Beginner's Guide to PLC) to get examples of PLC electrical wiring. (f) Figures of the SMC Pneumatic System as follows: SMC panel SMC pneumatic modules
6.	**References:**